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Spokane County, Washington

National Eutrophication Survey, Las Vegas, Nevada

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U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

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Report
on
Medical Lake
Spokane County
Washington
EPA Region X
Working Paper No. 871

With the cooperation of the
Washington Department of Ecology
and the
Washington National Guard
July, 1977

REPORT ON MEDICAL LAKE

SPOKANE COUNTY, WASHINGTON

EPA REGION X

by

National Eutrophication Survey

Water and Land Quality Branch
Monitoring Operations Division
Environmental Monitoring & Support Laboratory
Las Vegas, Nevada

and

Special Studies Branch
Corvallis Environmental Research Laboratory
Corvallis, Oregon

Working Paper No. 871

OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY

July 1977

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point source discharge reduction and nonpoint source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's freshwater lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by the U.S. Environmental Protection Agency and to augment plans implementation by the states.

ACKNOWLEDGMENTS

The staff of the National Eutrophication Survey (Office of Research and Development, U.S. Environmental Protection Agency) expresses sincere appreciation to the Washington Department of Ecology for professional involvement, to the Washington National Guard for conducting the tributary sampling phase of the Survey, and to those Washington wastewater treatment plant operators who provided effluent samples and flow data.

Ms. Barbara Blau, Lake Restoration Program, and the staff of the Washington Department of Ecology, Lake Restoration Program, provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports and provided critiques most useful in the preparation of this Working Paper Series.

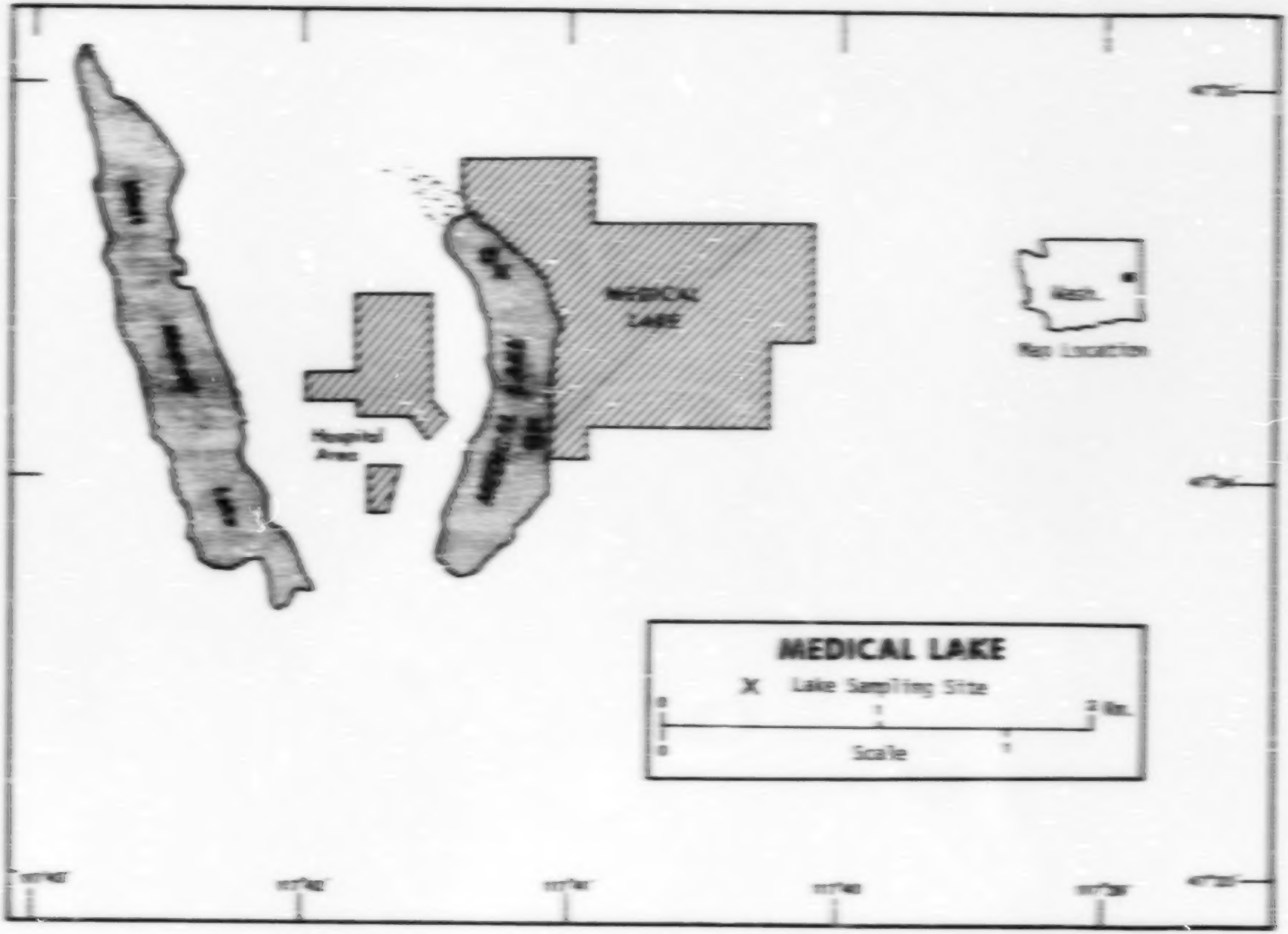
Major General Howard S. McGee, Adjutant General of Washington, and Project Officer Colonel Clinton C. Johnson, who directed the volunteer efforts of the Washington National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF WASHINGTON

LAKE NAME	COUNTY
American Lake	Pierce
Banks Lake	Grant, Douglas
Chelan Lake	Chelan
Diamond Lake	Pend Oreille
Green Lake	King
Keechelus Lake	Kittitas
Mayfield Lake	Lewis
Medical Lake	Spokane
Moses Lake	Grant
Ozette Lake	Clallam
Sammamish Lake	King
Lake Whatcom	Whatcom
Lower Granite Reservoir	Garfield, Whatcom


MEDICAL LAKE
X Lake Sampling Site
Scale

REPORT ON MEDICAL LAKE, WASHINGTON

STORET NO. 5308

I. INTRODUCTION

Medical Lake was included in the National Eutrophication Survey (NES) as a water body of special interest to the Washington State Department of Ecology. Tributaries and nutrient sources were not sampled, and this report relates only to lake sampling data.

Medical Lake lies adjacent to the west side of the Town of Medical Lake in Spokane County. There is no surface-water outlet from the lake (McConnell, et al., 1976); Walcott (1973) reports that the oxygen supply is inadequate to support a fish population, presumably due to a high level of organic material in the water. Rehabilitation treatments to the lake were applied by the Washington Department of Game in 1957 (Blau, personal communication). Present restoration efforts by the Town of Medical Lake include precipitation of phosphorus to reduce nuisance blue green algae blooms (Fiedler, personal communication).

II. CONCLUSIONS

A. Trophic Condition:*

Survey data indicate that Medical Lake is hypereutrophic. Chlorophyll *a* values ranged from a low of 1.5 µg/l in June

*See Appendix C.

to a high of 36.6 µg/l in July with a mean of 16.4 µg/l. Secchi disc visibility in the lake was relatively low on all but the June sampling date and the potential for primary productivity as measured by algal assay control yields was extremely high throughout the sampling year. Of the 13 Washington lakes sampled in 1975, none had greater total phosphorus levels (0.275 mg/l) or median dissolved orthophosphorus values (0.166 mg/l), and only one had higher median inorganic nitrogen levels (0.225 mg/l) than Medical Lake.

Survey limnologists reported an algal bloom on the July sampling date and emergent macrophytes during June and July. Other sources (Ketelle and Uttormark, 1971) note that Medical Lake is highly eutrophic and undergoes large blooms of Anacystis and Anabaena flos-aquae.

3. Rate-Limiting Nutrient:

Algal assay results indicate that Medical Lake was limited by available nitrogen levels during the sample collection times (06/03/75, 09/11/75, 10/22/75). The lake data generally substantiate nitrogen limitation throughout the sampling year.

III. LAKE CHARACTERISTICS

A. Lake Morphometry:*

1. Surface area: 0.64 km^2.
2. Mean depth: 9.7 meters.
3. Maximum depth: 18.3 meters.
4. Volume: 6.241 x 10^6 m^3.

B. Precipitation:

1. Year of sampling: 54.0 cm.
2. Mean annual: 44.2 cm.

*Wolcott, E.E., 1965.

IV. LAKE WATER QUALITY SUMMARY

Medical Lake was sampled four times during the open-water season of 1975 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from two stations on the lake and from a number of depths at each station (see map, page v). During each visit, depth-integrated samples were collected from each station for chlorophyll *a* analysis and phytoplankton identification and enumeration. During the first, third, and fourth visits, 18.9-liter depth-integrated samples were composited for algal assays. Maximum depths sampled were 8.5 meters at Station 01, and 15.5 meters at Station 02. For a more detailed explanation of NES methods, see NES Working Paper No. 175.

The results obtained are presented in full in Appendix B and are summarized in III-A for waters at the surface and at the maximum depth for each site. Results of the phytoplankton counts and chlorophyll *a* determinations are included in III-B. Results of the limiting nutrient study are presented in III-C.

[redacted]

[redacted]

[redacted]		[redacted]																		
[redacted]		[redacted]																		

[illegible] LAKE
STREET ROUTE 5705

PHYSICAL AND CHEMICAL CHARACTERISTICS

PARAMETER	MP	RANGE	MEAN	MED DEPTH (FEET)
TEMPERATURE (DEG C)				
[illegible]	4	13.4- 22.1	17.9	0.5- 1.5
[illegible]	2	13.4- 22.1	17.9	7.5- 8.5
DISSOLVED OXYGEN (MG/L)				
[illegible]	4	5.1- 5.4	5.3	0.5- 1.5
[illegible]	2	4.9- 5.8	5.7	7.5- 8.5
CONDUCTIVITY (UMHO)				
[illegible]	4	1787.-1885.	1836.	0.5- 1.5
[illegible]	2	1798.-1885.	1837.	7.5- 8.5
PH (STANDARD UNITS)				
[illegible]	4	6.2- 6.3	6.3	0.5- 1.5
[illegible]	2	6.2- 6.3	6.3	7.5- 8.5
TOTAL ALKALINITY (MG/L)				
[illegible]	4	1398.-1440.	1395.	0.5- 1.5
[illegible]	1	1440.-1440.	1440.	7.5- 7.5
TOTAL P (MG/L)				
[illegible]	4	0.263-0.304	0.279	0.5- 1.5
[illegible]	2	0.273-0.276	0.275	7.5- 8.5
DISSOLVED ORTHO P (MG/L)				
[illegible]	4	0.243-0.266	0.254	0.5- 1.5
[illegible]	1	0.254-0.254	0.254	7.5- 7.5
NO3+NO2 (MG/L)				
[illegible]	4	0.179-0.229	0.211	0.5- 1.5
[illegible]	1	0.227-0.227	0.227	7.5- 7.5
AMMONIA (MG/L)				
[illegible]	4	0.229-0.233	0.230	0.5- 1.5
[illegible]	2	0.230-0.233	0.232	7.5- 8.5
CHLOROPHYLL A (UG/L)				
[illegible]	4	2.459-2.489	2.474	0.5- 1.5
[illegible]	2	2.459-2.489	2.589	7.5- 8.5
SECCHI DISC (METERS)				
	2	1.5- 1.5	1.5	

* = [illegible]
** = [illegible]
*** = [illegible]

B. Biological Characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
06/03/75	1. Chroomonas	769
	2. Schroederia	670
	3. Phormidium	271
	4. Cryptomonas	226
	Other genera	...
	Total	1,944
07/23/75	1. Sitzschia	2,267
	2. Microcystis	599
	3. Cryptomonas	385
	4. Chroomonas	342
	5. Aphanocapsa	247
	Other genera	394
	Total	4,234
09/11/75	1. Microcystis	1,060
	2. Phormidium	1,147
	3. Fragilaria	661
	4. Cryptomonas	229
	5. Pennate Diatom	229
	Other genera	277
	Total	3,993
10/24/75	1. Fragilaria	2,032
	2. Anabaena	290
	3. Microcystis	145
	Other genera	...
	Total	2,467

F. Chlorophyll A -

Sampling Date	Station Number	Chlorophyll A (ug/l)
06/03/75	01	1.6
	02	1.9
07/23/75	01	14.3
	02	36.6
09/11/75	01	29.0
	02	16.0
10/24/75	01	12.1
	02	16.1

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

a. 06/03/75

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum Yield (mg/l-dry wt.)
Control	0.315	0.380	30.5
0.05 P	0.365	0.380	41.7
0.05 P + 1.0 N	0.365	1.380	70.9
1.00 N	0.315	1.380	69.1

b. 09/11/75

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum Yield (mg/l-dry wt.)
Control	0.075	0.135	9.0
0.05 P	0.125	0.135	8.6
0.05 P + 1.0 N	0.125	1.135	31.4
1.00 N	0.075	1.135	22.0

c. 10/22/75

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum Yield (mg/l-dry wt.)
Control	0.105	0.275	13.4
0.05 P	0.155	0.275	13.4
0.05 P + 1.0 N	0.155	1.275	47.4
1.00 N	0.105	1.275	44.8

F. Discussion -

The control yields of the assay alga, Selenastrum capricornutum, indicate that the potential for primary production at the times of sampling (06/03/75, 09/11/75, 10/22/75) in Medical Lake was extremely high. In each sample, a significant increase in growth over that of the control was produced by the addition of nitrogen alone, indicating nitrogen limitation. The addition of phosphorus alone stimulated growth beyond the control yield only in the June assay. Spikes with nitrogen and phosphorus simultaneously resulted in maximum growth yields in all three samples.

The mean inorganic nitrogen to orthophosphorus ratios (N/P) in sampled waters of 2/1 in June, 5/1 in July, 2/1 in September, and 1/1 in October further suggest nitrogen limitation (a mean N/P ratio of 14/1 or greater generally reflects phosphorus limitation).

V. LITERATURE REVIEWED

Blau, Barbara. 1977. Personal communication (restoration of Medical Lake). Washington Department of Ecology, Olympia, Washington.

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U.S. Environmental Protection Agency. 1975. National Eutrophication Survey Methods 1973-1976. Working Paper No. 175. National Environmental Research Center, Las Vegas, Nevada, and Pacific Northwest Environmental Research Laboratory, Corvallis, Oregon.

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VI. APPENDICES

APPENDIX A
CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX B
PHYSICAL AND CHEMICAL DATA

[illegible]

APPENDIX C

PARAMETRIC RANKINGS OF LAKES SAMPLED BY NES IN 1975

STATE OF WASHINGTON

Mean or median values for six of the key parameters evaluated in establishing the trophic conditions of Washington lakes sampled are presented to allow direct comparison of the ranking, by parameter, of each lake relative to the others. Median total phosphorus, median inorganic nitrogen and median dissolved orthophosphorus levels are expressed in mg/l. Chlorophyll a values are expressed in ug/l. To maintain consistent rank order with the preceding parameters, the mean Secchi disc depth, in inches, is subtracted from 600. Similarly, minimum dissolved oxygen values are subtracted from 15 to create table entries.

[illegible] DATA TO BE USED IN RANCHER

LAKE CODE	LAKE NAME	[illegible] TOTAL P	[illegible] INORG N	SUB- [illegible] SEC	[illegible] CHLSPA	15- [illegible] DE	[illegible] SECCHI DEPTH M
5301	[illegible] LAKE	0.027	0.195	343.800	4.822	25.000	0.807
5302	[illegible] LAKE	0.021	0.340	364.533	7.373	18.800	0.887
5303	[illegible] LAKE	0.005	0.870	111.900	0.405	6.400	0.873
5304	[illegible] LAKE	0.054	0.300	303.467	14.537	14.200	0.312
5305	[illegible] LAKE	0.027	0.250	425.000	2.943	10.400	0.809
5306	[illegible] LAKE	0.007	0.340	286.250	1.468	9.200	0.902
5307	[illegible] LAKE	0.034	0.199	402.000	4.250	10.400	0.807
5308	[illegible] LAKE	0.075	0.205	491.714	18.425	15.300	0.144
5309	[illegible] LAKE	0.125	0.150	463.600	29.000	14.070	0.038
5310	[illegible] LAKE	0.010	0.110	405.333	1.225	7.200	0.894
5311	[illegible] LAKE	0.025	0.220	374.000	7.240	14.600	0.834
5312	[illegible] LAKE	0.009	0.320	298.000	3.427	10.400	0.894
5313	[illegible]	0.033	0.150	495.500	4.875	7.200	0.822

[illegible] OF LAKES WITH [illegible] VALUES [illegible] OF LAKES WITH [illegible] VALUES

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	90%- MEAN SEC	MEAN CHLOR	15- MEAN SD	MEDIAN BIOS ORTHO P
5301	AMERICAN LAKE	29 (35	50 (60	67 (80	50 (60	4 (29	50 (71
5302	BANKS LAKE	42 (50	100 (120	50 (71	25 (33	46 (50	71 (40
5303	CHELAN LAKE	100 (120	67 (50	100 (120	100 (120	100 (120	50 (111
5304	DIAMOND LAKE	67 (71	75 (90	75 (90	17 (21	33 (40	25 (22
5305	GREEN LAKE	29 (33	83 (100	17 (21	75 (90	67 (71	44 (40
5306	HEDREUS LAKE	92 (111	92 (111	92 (111	83 (100	75 (90	100 (125
5307	HATFIELD LAKE	67 (71	50 (71	33 (40	50 (71	62 (71	71 (90
5308	MEDICAL LAKE	0 (00	0 (11	67 (50	0 (11	4 (01	0 (00
5309	MOSES LAKE	0 (11	20 (33	0 (00	0 (00	21 (25	0 (11
5310	OSETTE LAKE	75 (90	42 (50	25 (33	92 (111	67 (100	33 (40
5311	SAMMAMISH LAKE	50 (60	17 (25	50 (60	33 (40	21 (25	40 (100
5312	WHATCOM LAKE	83 (100	0 (00	83 (100	67 (80	46 (50	46 (50
5313	LOWER GRANITE RESERVOIR	17 (25	20 (33	0 (11	42 (50	67 (100	17 (50

TECHNICAL REPORT DATA

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16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
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